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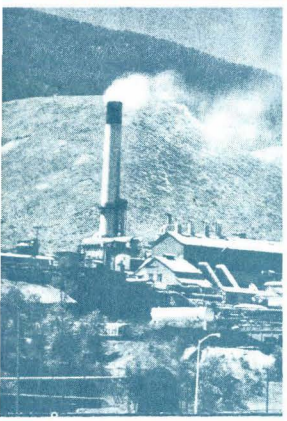

FOREST ENVIRONMENTAL PROTECTION

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NATURAL MORTALITY IN A DOUGLAS-FIR TUSSOCK MOTH INFESTATION IN NORTHERN IDAHO - 1974.

By

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ABSTRACT

Mortality from various causes was recorded in a Douglas-fir tussock moth, *Orgyia pseudotsugata* McD., outbreak southeast of Coeur d'Alene, Idaho, in 1974. Observations began June 27 when about 50 percent of the larvae were second instars and continued until pupation. Within a 35-day period, there was a 93 percent average reduction in population. Approximately 36.7 percent of the population collected and reared in the laboratory died from unknown causes; 11 percent were parasitized; and 3.4 percent were killed by nucleopolyhedrosis virus. *Phobocampe* n.s. was the most abundant parasite and attacked all instars.

Unlike most other past outbreaks, this one did not collapse at the end of 3 years due to virus and parasites. Egg masses were found in infested areas during the fall of 1974.

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INTRODUCTION

In the Northern Region, Douglas-fir tussock moth, *Orgyia pseudotsugata* McD., outbreaks last from 2 to 4 years in forested areas (Tunnock, 1973). Factors causing population declines are diseases, (mainly nucleopolyhedrosis virus) parasites and predators, and starvation (Tunnock, 1966; Johnson, 1949, and Wickman *et al.*, 1973).

An 18,867-acre area southeast of Coeur d'Alene, Idaho, was infested with *O. pseudotsugata* in 1974 (Tunnock *et al.*, 1974). This area was selected for a pilot control test of two microbial insecticides--the bacterium *Bacillus thuringiensis* Berliner, and a nucleopolyhedrosis virus. In conjunction with this project, an evaluation of factors causing natural mortality was to be made. The pilot control project was aborted when prespray samples indicated that there were insufficient numbers of larvae in spray blocks (McGregor *et al.*, 1974). However, the "natural mortality" study was continued until pupation.

The objective of this study was to obtain data on natural mortality during a declining phase of an *O. pseudotsugata* outbreak.

METHODS

Sample design.--Nine blocks, varying in size from 1,000 to 3,000 acres (Figure 1), were established in the infested area for the pilot control project. Each block contained 80 sample trees arranged in clusters of five. Sample trees ranged from 20 to 50 feet in height and were either grand fir, *Abies grandis* (Dougl.) Lindl.; or Douglas-fir, *Pseudotsuga menziesii* var. *glauca* (Beissn.) Franco.

Sampling schedule.--Larval populations were first sampled June 27 to 29, when about 50 percent were in the second instar. They were again sampled approximately 7, 21, and 35 days later, and when cocoons became abundant. Mortality from egg hatch, (June 18 until June 27) was not evaluated.

Field aspects.--Two 18-inch branches were clipped from opposite sides of each tree and caught in a cloth basket attached to the end of a pole pruner. Each branch was placed on a white cloth and its length and width (at the widest point) measured. Larvae were dislodged from branches onto the cloth. Number of larvae per branch were recorded. Up to 10 larvae per sample tree were collected and placed individually in small Petri dishes for rearing.

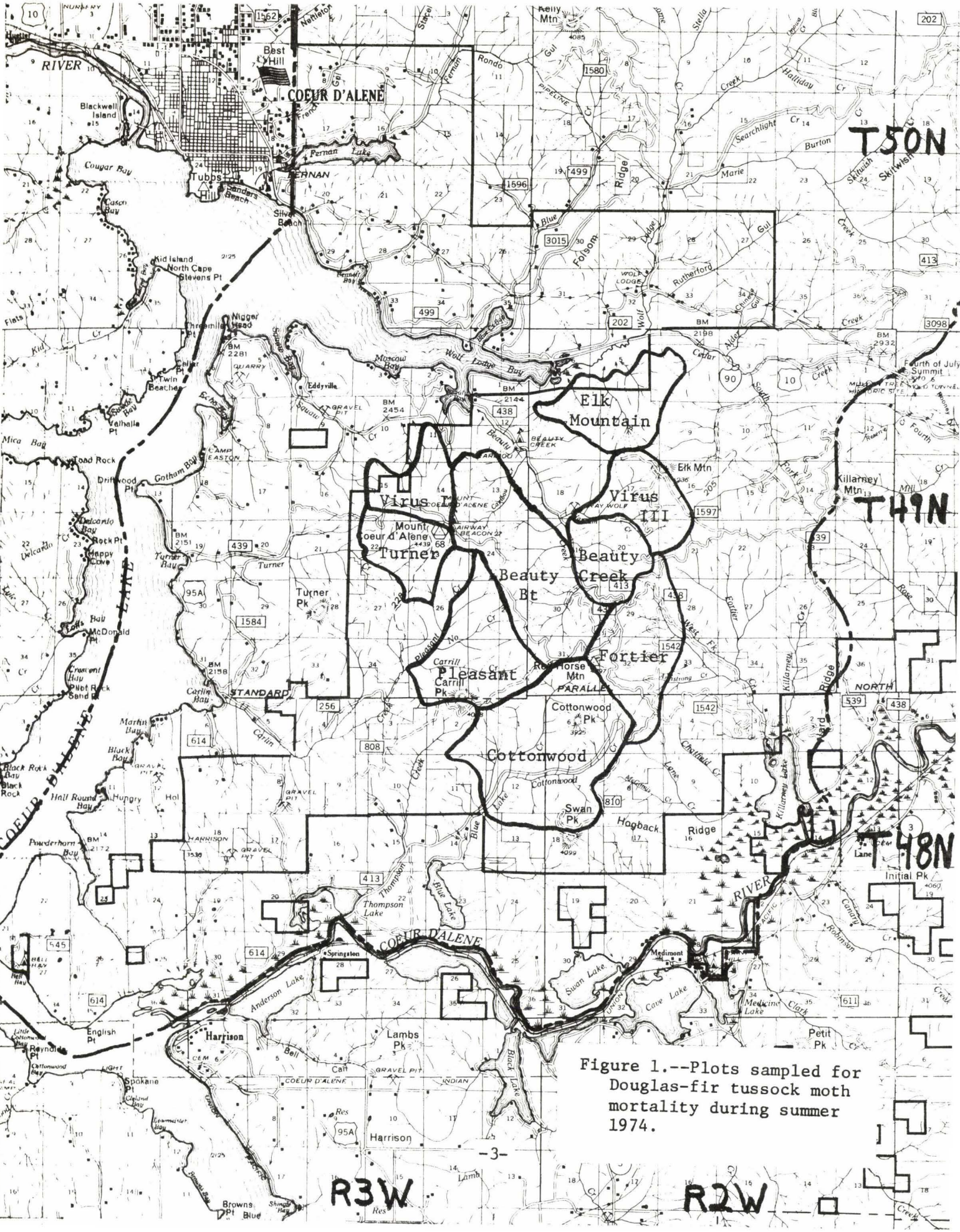

Figure 1.--Plots sampled for Douglas-fir tussock moth mortality during summer 1974.

Laboratory aspects.--Larvae were delivered to a laboratory in Coeur d'Alene and reared on artificial media[3/]. Body contents of each larva that died were examined microscopically at 450X for the presence of polyhedral bodies (containing virus rods). Parasites recovered from larvae were submitted to the U.S. National Museum for identification.

Larvae per thousand square inches of foliage were computed for each plot each sampling period.

RESULTS

Larval population decline.--There was a marked decrease in numbers of larvae per 1,000 square inches of foliage over a 35-day period in the nine plots (Table 1). Populations ranged from 1.8 to 45.0 larvae per 1,000 square inches of foliage during the first sample, and 0.1 to 2.0 after 35 days, or a 93 percent average reduction in population.

Table 1.--*O. pseudotsugata* larvae per 1,000 square inches foliage on plots periodically sampled within the Coeur d'Alene infestation during summer 1974.

Plot name	Larvae/1,000 square inches foliage				Percent reduction in 35 days
	First sample (6/27-29)	7 days later (7/3-12)	21 days later (7/22-30)	35 days later (8/5-13)	
Virus I	----	0.8	0.7	0.1	87
Cottonwood	7.0	3.2	.4	.1	99
Virus III	20.0	15.0	7.5	2.0	90
Turner	45.0	12.2	2.9	.6	99
Beauty Bt	27.0	49.0	3.8	1.6	94
Pleasant	16.0	3.5	3.2	1.5	91
Elk Mountain	1.8	.9	.2	.2	89
Beauty check	6.0	1.2	.8	.3	95
Fortier	10.0	8.0	1.2	.4	96
Average					93

3/ Artificial media was supplied by the Forestry Sciences Laboratory, Pacific Northwest Forest and Range Experiment Station, Corvallis, Oregon.

Mortality from unknown causes, parasites, and virus in nine different areas during five collection periods is shown in Table 2.

On the average, mortality from unknown causes fluctuated from 2.9 to 48.4 percent, the latter occurring during the 35-day collection. Parasitism by Hymenoptera varied very little (range 7.9 to 10.8 percent) during the first four collections, but decreased to 5.0 percent by the time cocoons were spun. Parasitism by Diptera increased (from 0.04 percent) each collection period and finally killed 15.1 percent of the prepupae and pupae collected. Mortality from virus increased from 2.6 to 6.3 percent at 35 days, but virused prepupae or pupae were not found (Table 2).

Data from all the collection periods were combined to show percent mortality in each of the nine areas from various causes (Table 3). Mortality from unknown causes ranged from 21.4 to 43.9 percent and the highest was in the Turner plot. Parasitism by Hymenoptera ranged from 5.9 to 25.7 percent with the greatest amount in Virus I plot. Parasitism by Diptera ranged from 0 to 4.2 percent and was highest in the Pleasant plot. Mortality from virus was highest in the Virus I plot, and ranged from 2.1 to 5.7 percent.

Of all tussock moths collected, 11.0 percent were killed by parasites and 3.4 percent from virus. Approximately 36.7 percent died from unknown causes such as bacterial diseases, yeasts, and rearing conditions (Table 3).

Parasites.--Several species of dipterous parasites emerged as maggots in the laboratory from field-collected tussock moths (larvae, prepupae, and pupae). None were reared to adults. Thirteen hymenopterous parasites were identified and are listed in Table 4. The Ichneumonid, *Phobocampe* n.s., was the most abundant parasite and parasitized all instars.

DISCUSSION

Overall, mortality from parasites and virus was relatively low within the Coeur d'Alene infestation (Table 3). Of 6,689 tussock moths collected, 48.9 percent emerged as adults, 11 percent were parasitized, and 3.4 percent died from virus. This low level of virus was tentatively predicted during March of 1974 from 1973 egg masses collected within the infestation. Eggs hatched in the laboratory and percentage of larvae dying from virus after 14 days averaged 1.1 percent (Tunnock, *et al.*, 1974). Wickman, *et al.*, (1973) reported on five outbreaks in Oregon and California from 1935 to 1965. Each outbreak collapsed at the end of 3 years and a virus disease appeared to be the principal cause. The Coeur d'Alene infestation started in 1972 and declined in 1974, but not due to virus. Therefore, population collapse at the end of 3 years cannot always be attributed to virus.

Data from the cocoon collection (Table 2) indicated there would be some egg masses laid in several areas during 1974, because adult emergence averaged 40.6 percent. During the fall of 1974, 18 sections were sampled and contained new egg masses (McGregor *et al.*, 1974). Only four sections had over 0.1 egg mass per 1,000 square inches of foliage, which meant defoliation would probably be noticeable on them in 1975 (Tunnock and Livingston, 1974). However, no current year's defoliation was detected in these areas during aerial surveys in 1975.

In comparison, a similar mortality study was made near Moscow, Idaho, in 1965. Evidence that this outbreak was developing was detected in 1963 (Tunnock, 1973). Natural mortality was monitored at weekly intervals for 7 weeks (Tunnock, 1966). Larval mortality from virus was as high as 82.4 percent during one collection period. Parasites killed 15.6 percent during the seventh week and mortality from unknown causes ranged from 1.6 to 2.2 percent.

Five species of Hymenoptera were recovered in the Moscow infestation. These wasps did not emerge from their cocoons; therefore, identification to species was not made. A Tachinid fly, *Carcelia yalensis* Sellers, was very abundant in the field and probably parasitized many larvae.

The Moscow infestation, unlike the one near Coeur d'Alene, collapsed after 3 years due to diseases (mainly virus) and parasites. No new egg masses were found within the infested area in 1965 (Tunnock, 1966).

Table 2.--Percent mortality of Douglas-fir tussock moths reared in a laboratory at Coeur d'Alene, Idaho during the summer of 1974.

Plot name	First collection[1]						7th-day collection[2]						21st-day collection						35th-day collection						Cocoon collection[3]					
	Total collected	Emerged as adults	Died of unknown causes	Hymenoptera parasites	Diptera parasites	Died of virus	Total collected	Emerged as adults	Died of unknown causes	Hymenoptera parasites	Diptera parasites	Died of virus	Total collected	Emerged as adults	Died of unknown causes	Hymenoptera parasites	Diptera parasites	Died of virus	Total collected	Emerged as adults	Died of unknown causes	Hymenoptera parasites	Diptera parasites	Died of virus	Total collected	Emerged as adults	Died of unknown causes	Hymenoptera parasites	Diptera parasites	Died of virus
Virus I	-	-	-	-	-	-	35	34.3	28.6	28.6	0	8.6	31	58.1	12.9	25.8	0	3.2	4	50.0	25.0	0	25.0	0	-	-	-	-	-	-
Cottonwood	164	46.3	39.6	11.5	0	2.4	126	57.1	30.1	7.9	0	4.8	25	60.0	16.0	16.0	4.0	4.0	5	80.0	20.0	0	0	0	-	-	-	-	-	-
Virus III	522	50.9	39.3	9.0	0	.7	385	54.5	36.1	7.5	0	1.8	215	60.9	30.7	2.3	0	6.0	143	34.3	48.9	2.1	5.6	9.1	206	38.3	41.3	2.9	17.5	0
Turner	580	40.5	49.1	6.2	0	4.1	377	40.0	44.8	7.5	0	7.7	163	61.9	23.9	11.6	0	2.4	37	21.6	51.3	21.6	0	5.4	78	50.0	38.5	2.6	8.9	0
Beauty Bt.	628	53.0	36.3	9.1	0	1.6	705	56.3	26.4	13.0	0	4.2	251	61.3	23.5	10.7	0	4.4	72	30.5	56.9	6.9	2.8	2.8	39	35.9	53.8	5.1	5.1	0
Pleasant	329	54.7	37.9	6.4	0	.9	124	45.2	39.5	4.0	0	11.3	90	64.4	17.8	15.5	0	2.2	71	35.2	52.1	7.0	0	5.6	307	42.3	37.8	7.2	12.7	0
Elk Mountain	53	45.3	35.8	13.2	0	5.7	43	62.8	25.6	11.6	0	0	11	81.8	9.1	9.1	0	0	10	50.0	30.0	0	20.0	0	-	-	-	-	-	-
Beauty check	163	42.9	39.3	15.9	0	1.8	35	62.8	31.4	5.7	0	0	28	60.7	14.3	21.4	0	3.6	13	61.5	7.7	23.1	0	7.7	-	-	-	-	-	-
Fortier	317	38.5	40.4	14.5	0.3	6.3	241	44.4	43.1	9.5	0	2.9	75	66.7	14.7	16.0	0	2.7	23	21.7	43.5	26.1	0	8.7	65	32.3	30.8	4.6	32.3	0
Grand total	2,656						2,071						889						378						695					
Averages		47.2	40.7	9.4	.04	2.6		50.9	34.6	9.8	0	4.6		62.2	22.9	10.8	0.1	3.9		33.9	48.4	7.9	3.4	6.3		40.6	39.3	5.0	15.1	0

1/ Collected June 27 to 29, 1974.
2/ Collection began about 7 days from end of first collection.
3/ Prepupae and pupae died in cocoons.

Table 3.--Douglas-fir tussock moth mortality in nine areas near Coeur d'Alene, Idaho during the summer of 1974.

Plot name	Total collected	Percent mortality from various causes				
		Emerged as adults	Died of unknown causes	Hymenoptera parasites	Diptera parasites	Died of virus
Virus I	70	45.7	21.4	25.7	1.4	5.7
Cottonwood	320	52.2	33.7	10.3	.3	3.4
Virus III	1,371	49.9	38.4	5.9	3.2	2.6
Turner	1,235	43.2	43.9	7.5	.6	4.8
Beauty Bt	1.695	54.3	31.6	10.8	.2	3.1
Pleasant	921	48.7	37.2	7.2	4.2	2.5
Elk Mountain	117	55.5	29.0	11.1	1.7	2.6
Beauty check	239	48.9	33.5	15.5	0	2.1
Fortier	721	42.2	38.0	12.5	3.0	4.3
Grand total	6,689					
Averages		48.9	36.7	9.2	1.8	3.4

Table 4.--Hymenopterous parasites collected from *O. pseudotsugata*, Coeur d'Alene, Idaho, 1974.

Parasite	Life stages attacked	Rank of abundance[1/]
Ichneumonidae[2/]		
Phobocampe n.s.	All instars; mostly early	1
Mesochorus sp. (hyper parasite of *Phobocampe*		11
Phobocampe pallipes (Prov.)	All instars	3
Hyposoter n.s.	1st to 4th instars	4
Iseropus stercorator orgyiae (Ashm.)	Prepupae and pupae	7
Itoplectis viduata (Grav)	Prepupae and pupae	9
Theronia stalantae fulvescens (Cr.)	Prepupae and pupae	5
Ephialtes componotus (Davis)	Prepupae and pupae	10
Eulophidae[3/]		
Euplectrus sp.	2nd or 3rd instars	(Only one collected)
Braconidae[4/]		
Bracon xanthonotus Ashm.	Prepupae or pupae	(Only one collected)
Apanteles spp.	1st to 4th instars	8
Meteorus hyphantriae Riley	1st to 3rd instars	6
Meteorus tersus Mues.	All instars; mostly early	2

1/ One, most abundant--two, second in abundance, etc.
2/ Determined by R.W. Carlson, U.S. National Museum.
3/ Determined by G. Gordh, U.S. National Museum.
4/ Determined by P.M. Marsh, U.S. National Museum

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